Energy Technologies Area Lawrence Berkeley National Laboratory

Advances in Efficiency EM&V - DOE's Uniform Methods Project and M&V 2.0

May 23, 2017

EM&V Webinars Facilitated By:
Lawrence Berkeley National Laboratory
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U.S. Environmental Protection Agency

National Association of Regulatory Utility Commissioners
National Association of State Energy Officials

Introduction

- LBNL is supported by the U.S. Department of Energy to conduct non-classified research, operated by the University of California

- Provides technical assistance to states—primarily state energy offices and utility regulatory commissions

The presentation was funded by the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability-National Electricity Delivery Division under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231.

Technical Assistance

- LBNL's provides technical assistance to state utility regulatory commissions, state energy offices, tribes and regional entities in these areas:
  - Energy efficiency (e.g., EM&V, utility programs, behavior-based approaches, cost-effectiveness, program rules, planning, cost recovery, financing)
  - Renewable energy resources
  - Smart grid and grid modernization
  - Utility regulation and business models (e.g., financial impacts)
  - Transmission and reliability
  - Resource planning
  - Fossil fuel generation
- Assistance is independent and unbiased
- LBNL Tech Assistance website: https://emp.lbl.gov/projects/technical-assistance-states
- US DOE Tech Assistance gateway: http://energy.gov/ta/state-local-and-tribal-technical-assistance-gateway

Webinar Series

- Webinars designed to support EM&V activities for documenting energy savings and other impacts of energy efficiency programs
- Funded by U.S. DOE in coordination with EPA, NARUC and NASEO
- Audience:
  - Utility commissions, state energy offices, state environment departments, and non-profits involved in operating EE portfolios
  - Particular value for state officials starting or expanding their EM&V
  - Evaluation consultants, utilities, consumer organizations and other stakeholders also are welcome to participate
- For more information (upcoming and recorded webinars, EM&V resources) see:
  - https://emp.lbl.gov/emv-webinar-series
  - General Contact: EMVwebinars@lbl.gov

Series Contact:
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Next Webinar

- More webinars coming for 2017 and beyond…

SEE Action Webinar – Behavior Programs and Persistence in Illinois
June 22, 2017 at 2:00 PM EDT
Register at: https://attendee.gotowebinar.com/register/6896716754482090498

This webinar will outline how the Illinois Technical Reference Manual accounts for the persistence of savings in the calculation of savings and cost-effectiveness from these types of programs.

Todays Webinar - Advances in EM&V

- The U.S. has 40 years of experience evaluating, measuring and verifying the impacts of efficiency activities
- While always improving, advances in EM&V have accelerated, because of
  - Increasing interest in efficiency and its impacts
  - Increased support for EM&V from government agencies
  - Improvements in EM&V standardization, data access, and analytical tools
- Two major areas of improvements covered in this webinar
  - U.S. Department of Energy's (DOE) Uniform Methods Project (UMP)
  - M&V 2.0
- Under the UMP, DOE is developing protocols for commercial and residential energy efficiency measures and programs, as well as cross cutting protocols
- M&V 2.0 is a term applied to advances, focusing on advanced and automated analytics and using the increases in data availability and granularity

Today's Speakers

- **DOE's Uniform Methods Project**
  - Michael Li, Senior Policy Advisor, U.S. Department of Energy
  - Arlis Reynolds, Principal, Cadmus Group - – DOE's Uniform Methods Project
- **M&V 2.0**
  - Ellen Franconi, Manager, Rocky Mountain Institute
  - Tim Guiterman, Director of Measurement & Optimization Solutions, EnergySavvy

U.S. DEPARTMENT OF ENERGY

Uniform Methods Project
Overview & Status Update

May 23, 2017

Michael Li
Office of Energy Efficiency and Renewable Energy

Arlis Reynolds
The Cadmus Group, Inc.

Overview

What is the Uniform Methods Project?

What have we done to date?

How are protocols written?

How is UMP used?

Develop and Publish Protocols for Savings Calculations of Energy Efficiency Measures

- Addresses most common residential and commercial efficiency measures in ratepayer funded programs
- Presents step-by-step calculations to determine gross savings
- Includes additional sections to address cross-cutting evaluation requirements

Project Goals & Benefits

Greater consistency of savings calculations

- Quickly establish good M&V practices
- Facilitate meaningful comparisons

Greater transparency reduces risks

Educational value to broad stakeholder community

- Protocols identify key inputs
- Documentation of methods and calculations
- Educating those new to EM&V

Supports development of best practices for energy efficiency

- Sets data requirements early on
- Confidence when setting and meeting savings targets

Intended Audience

- Jurisdictions with no existing protocols or TRMs
- Regulators
- Program Administrators
- Implementers
- Evaluators

Author Principles

1	Each measure protocol should clearly specify the recommended methodology for each step. Each alternative method or step, should be clearly labelled as an alternative.
2	Each measure should have a one page cover sheet or appendix that lists the elements of the recommended methodology.
3	Each measure protocol should reflect how evaluators should or currently do determine the savings (*refers to evaluators that work with large program budgets). Methods should not be aspirational unless it is reasonable to expect evaluators to adopt this new method. If the method represents a substantial improvement in the accuracy of the savings estimate an exception may be made but should be requested at the beginning.
4	If a measure protocol includes a decision matrix to identify the correct method, the protocol should include a cover sheet for the 2-3 most commons cases.
5	Each measure protocol should reference 1-3 M&V studies where the protocol can be seen applied to a large extent.

Protocols To Date

Phase 1 – April 2013

Efficiency Measures

- Residential Lighting
- HVAC, Unitary Commercial
- Commercial Lighting
- Residential Refrigerator Recycling
- Residential Whole-House Retrofit
- Commercial Lighting Controls
- HVAC, Residential Boilers and Furnaces

Cross-cutting Protocols

- Assessing Persistence and Other Evaluation Issues
- Metering
- Peak Demand and Time-Differentiated Energy Savings
- Sample Design
- Survey Design and Implementation for Estimating Gross Savings

Phase 2 – February 2015

Efficiency Measures

- Adjustable-Speed Drive Motors
- Chillers
- Commercial New Construction
- Commercial HVAC Controls — Energy Management Systems/Direct Digital Control systems
- Retrocommissioning
- Compressed Air Systems
- Data Center Efficiency — Servers and Data Storage
- Residential Behavioral Programs

Cross-cutting Protocols

- Net Savings

Phase 3

- **Combined Heat & Power**
  - Published in November 2016
- **Strategic Energy Management**
  - Coming soon

Phase 4 – Major Updates

- Whole building retrofit; DNV GL
- Small unitary and split system HVAC; DNV GL & Jacobson Energy
- Residential lighting; APEX Analytics
- Commercial and industrial lighting; Left Fork Energy & DNV GL

Phase 4 - Minor Updates

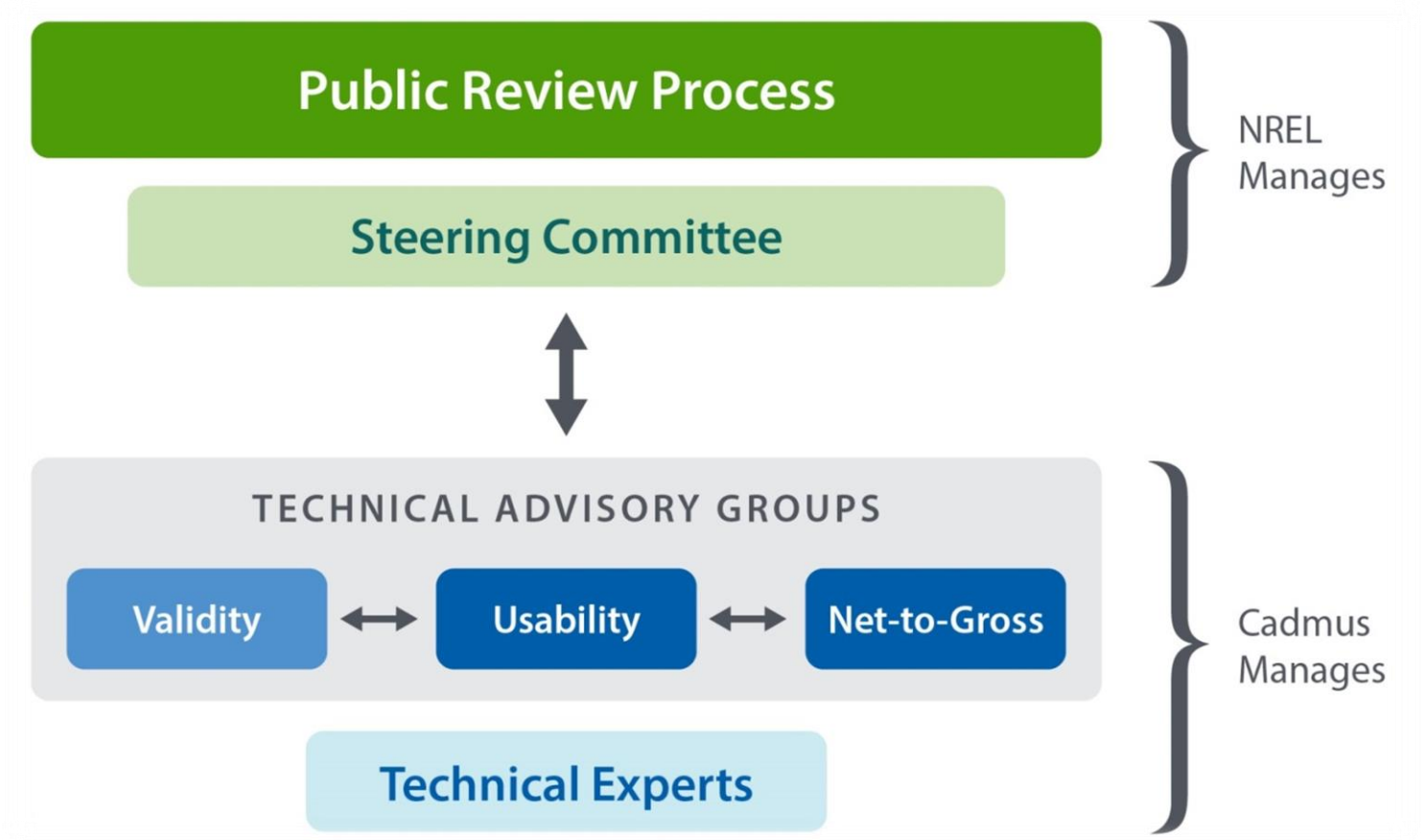
- Refrigerator recycling; Cadeo & Cadmus
- Residential behavior; Cadmus & LBNL
- Peak demand and time differentiated savings; Navigant
- Compressed air; Nexant
- Net savings; Navigant & Tetra Tech

Project Organization

Protocols developed in collaboration with evaluation experts and other energy efficiency stakeholders

- Protocols developed in collaboration with energy efficiency program administrators, stakeholders, and EM&V consultants
  - Including the major U.S. firms that do roughly 70% of energy efficiency evaluations
- Stakeholder Review process allows for input from a large array of stakeholders

UMP Management Structure



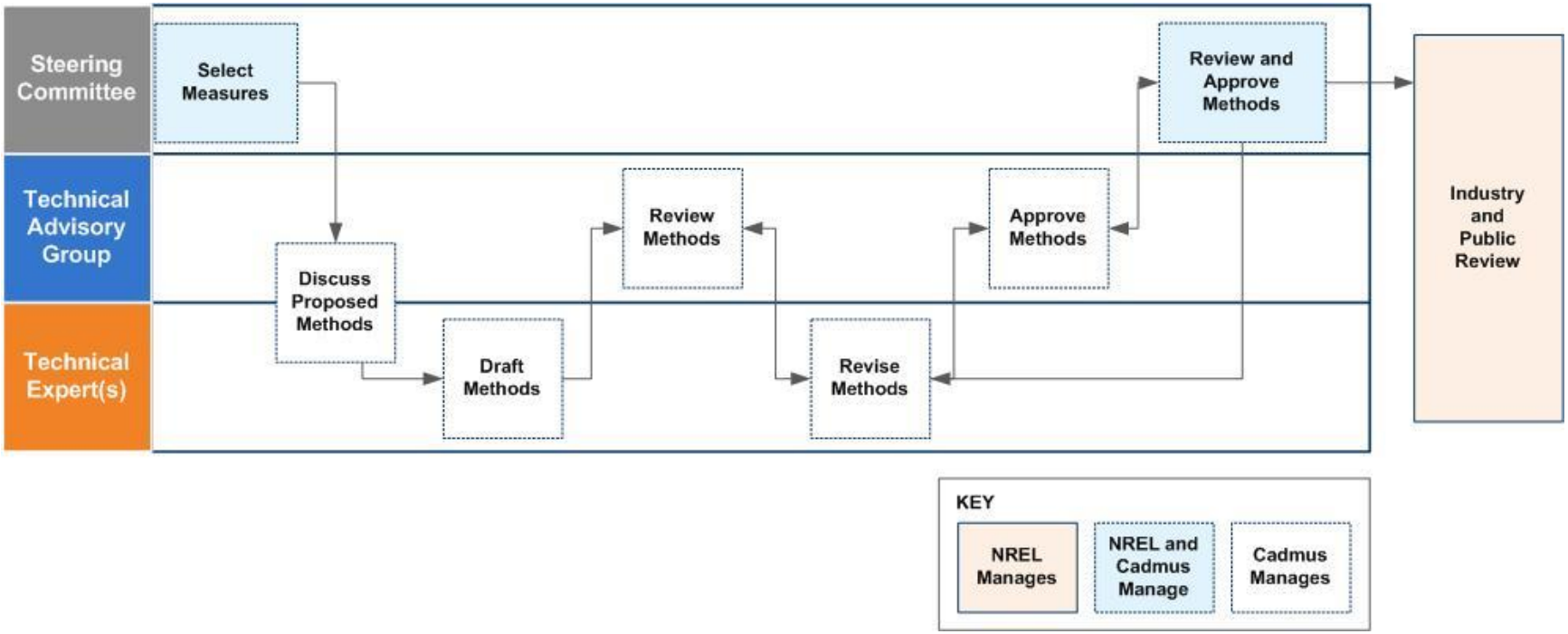
Roles (1 of 2)

DOE	• Project Sponsor (main client) • Articulates overarching goals; ensures UMP products meet DOE policy objectives • Outlines basic schedule and priorities
NREL	• Primary project manager; implement DOE direction • Creates and organizes the Steering Committee • Develops communication plan; administers the public comment process
Cadmus	• Provides technical support to NREL and the Steering Committee • Recruits TAG members and subcontracts with Technical Experts • Reports to NREL, manages TAG, TE, and TAG TE
Steering Committee	• Thought leaders with perspective on policy issues; promote adoption • Approves project structure, measures, final work product • Reports to NREL/DOE

Roles (2 of 2)

Technical Advisory Group (TAG)	• Provide EM&V technical guidance on usability and validity of protocol through the protocol development process • Reports to Cadmus
Technical Experts (TE)	• Primary authors of protocol chapters; develop protocols based on industry best practices • Discuss/revise at review stages with TAG TE, TAG, SC, and public review • Report to Cadmus
TAG Experts	• NEW role in Phase 3 • Provide measure-specific technical expertise at planning and review stages • Reports to Cadmus

Protocol Development Process



Technical Experts & Technical Advisory Group

U.S. DEPARTMENT OF ENERGY

ADM ENERGY RESEARCH AND EVALUATION

NAVIGANT CONSULTING

APEX ANALYTICS, LLC

WARREN ENERGY ENGINEERING, LLC

Left Fork Energy

Itron

Jacobson Energy Research LLC

KEMA DNV

BuildingMetrics, Inc

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Nexant

Pioneering Solutions for a Sustainable Energy Future

GDS Associates, Inc.
Engineers and Consultants

CADMUS

TETRA TECH

Adoption

- **Protocols published as a reference**
- **Voluntary in nature**
- **Three primary pathways for adoption**
  - Formally by regulators
  - Adopted by program administrators and provided to implementers and evaluators
  - Recommended to clients by evaluators

Who's Using Protocols and How?

EM&V Framework/Guidance

"Common frameworks and protocols allow consistency, transparency, and stream-lined processes, and should be adopted or developed across all areas discussed below. For example, DOE's UMP for project-specific M&V approaches provides useful guidelines for program administrators and M&V practitioners."

Technical Reference Manuals

2015 Pennsylvania, 2015 Illinois, 2015 Iowa

EM&V RFPs

"Unless otherwise recommended the evaluation company should follow existing [UMP] protocols for the evaluation of this program."

EM&V Proposals & Reports

Proposals & reports should reference the relevant UMP protocol and propose a consistent method or explain reasons for differing.

Who's Using Protocols and How?

U.S. DEPARTMENT OF ENERGY

Other/Misc.

Quadrennial Energy Review
EE programs have achieved significant energy savings, but using standard EM&V standards, like those recommended by DOE's Uniform Methods Project, is key to ensuring that all the benefits of efficiency are realized, including avoiding the expense of building new infrastructure.

In the News…

GreenBiz350
The EE industry has made progress toward standardization. The DOE-managed Uniform Methods Project is developing standardized algorithms for calculating savings from common EE measures…

What's In a Protocol?

- Measure Description
- Application Conditions of Protocol
- Savings Calculations
- Measurement and Verification Plan
- Other Evaluation Issues
- References/Resources
- Looking Back – Updates to past protocols
- Looking forward – Current research or expected changes to existing methods

Whole Building

Measure Description

- Whole house/building projects with multiple measures for which we must capture combined effects

Application Conditions of Protocol

- Multiple measures (or single measure if other conditions are true)
- Combined impacts are large enough given variation in consumption and savings, and sample size
- Baseline = pre-retrofit condition
- Sufficient data exist (before and after installation)

Savings Calculations

- 2-stage
- Pooled

Whole Building

Measurement and Verification Plan

- IPMVP Option C – "Billing Analysis"
- Verification not required
- Data requirements: consumption data (utility meter); program tracking data; weather data
- Methods describe:
  - Data requirements
  - Data prep
  - Data analysis
- "Sample" typically includes all program participants

Other Evaluation Issues

- Other applications or methods
- Alternative comparison groups

Whole Building

References/Resources

Looking Back – Updates to past protocols

- Expanded modeling options
- Expand to daily consumption (from monthly)
- Clarify language on comparison groups and net savings

Looking forward – Current research or expected changes to existing methods

- Higher-frequency data (e.g., AMI)
- EM&V 2.0 with rolling data collection

Questions?

Michael.Li@ee.doe.gov

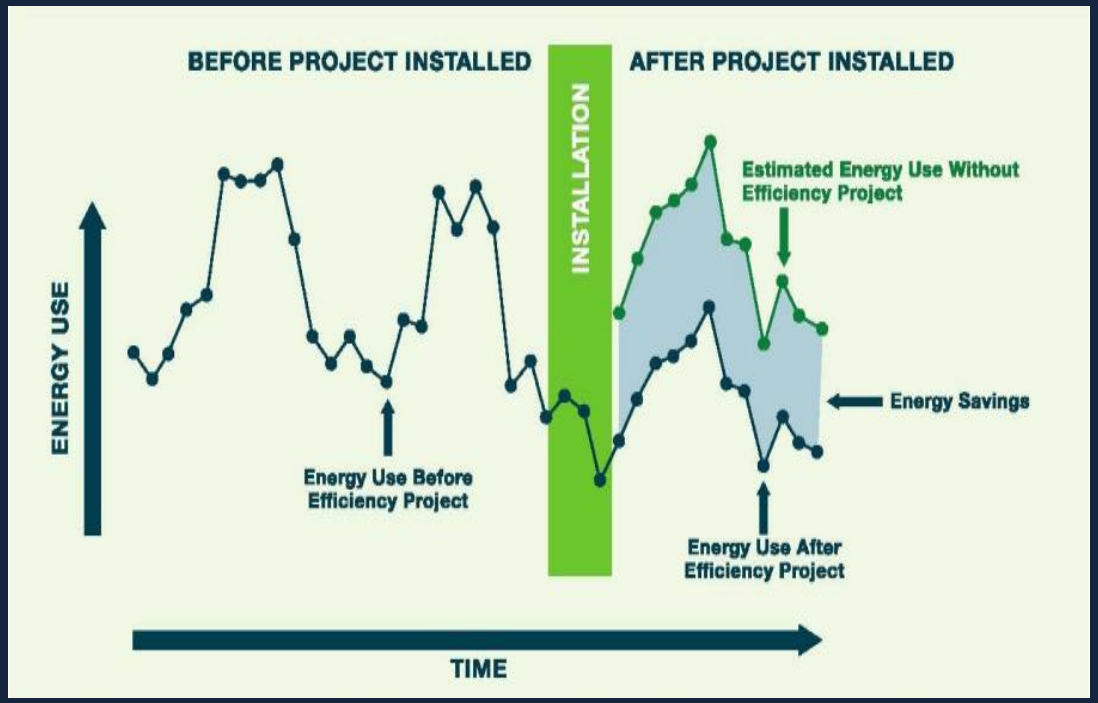
Arlis.Reynolds@cadmusgroup.com

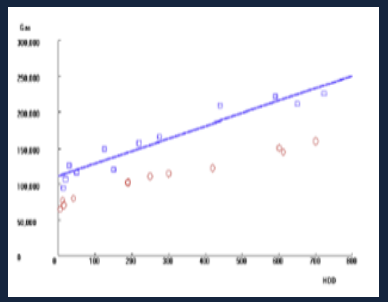
UMP Protocols: http://energy.gov/eere/about-us/ump-protocols

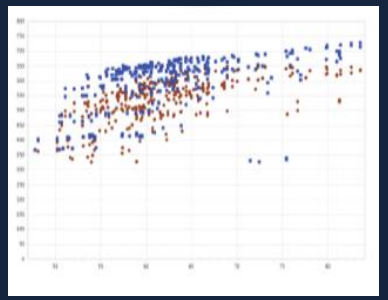
THE STATUS AND PROMISE OF ADVANCE M&V (M&V 2.0)

Ellen Franconi, Rocky Mountain Institute
Tim Guiterman, EnergySavvy

What is M&V 2.0?

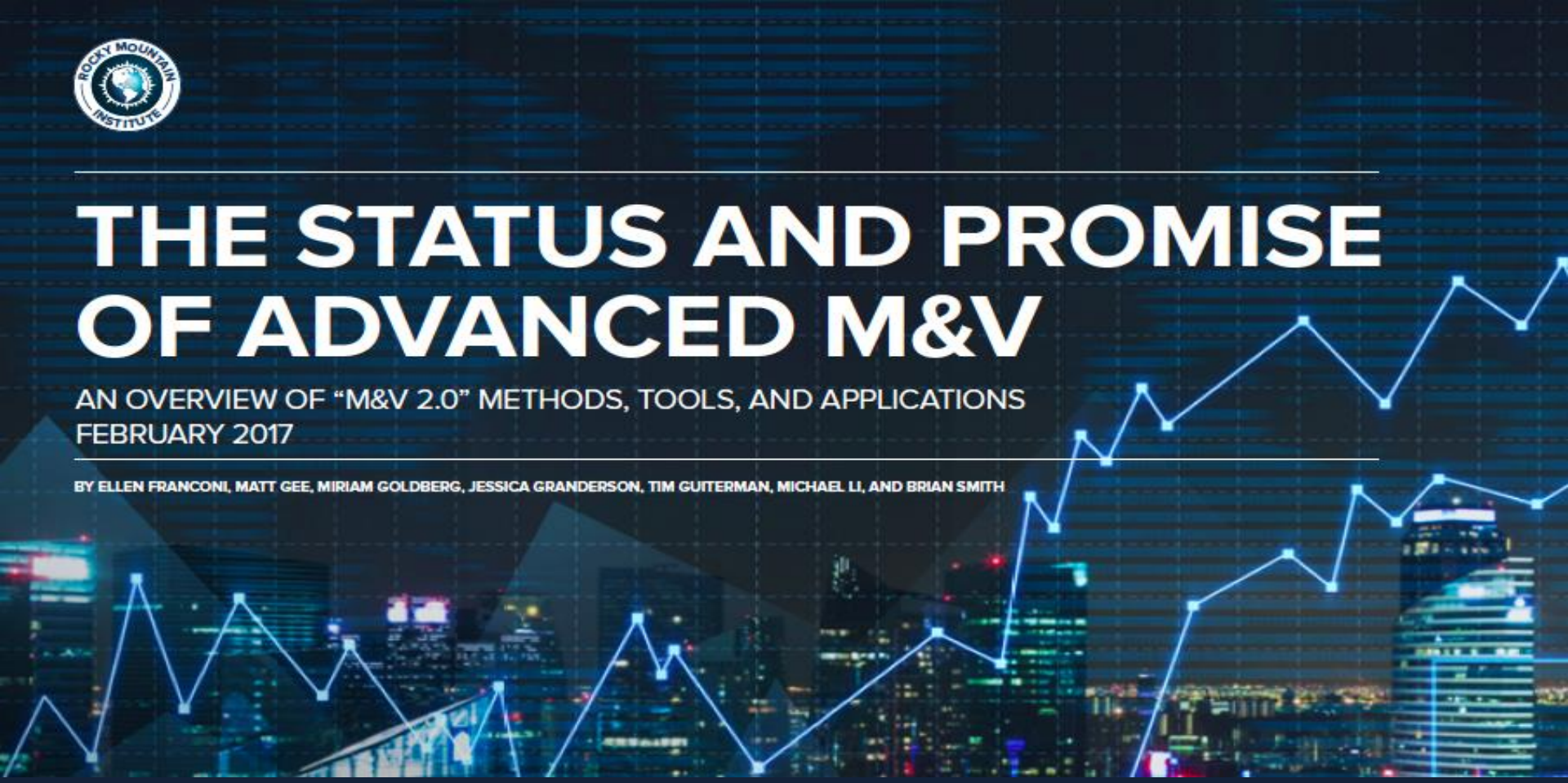






More granular data + More auto-mation + Advanced analytics = Near-real time savings

KEY FEATURES OF ADVANCED M&V



eLab M&V 2.0 Team

ELLEN FRANCONI (RMI), MATT GEE (OPENEE), JESSICA GRANDERSON (LBNL) **TIM GUITERMAN (ENERGYSAVVY)**, MICHAEL LI (DOE), BRIAN SMITH (PG&E)

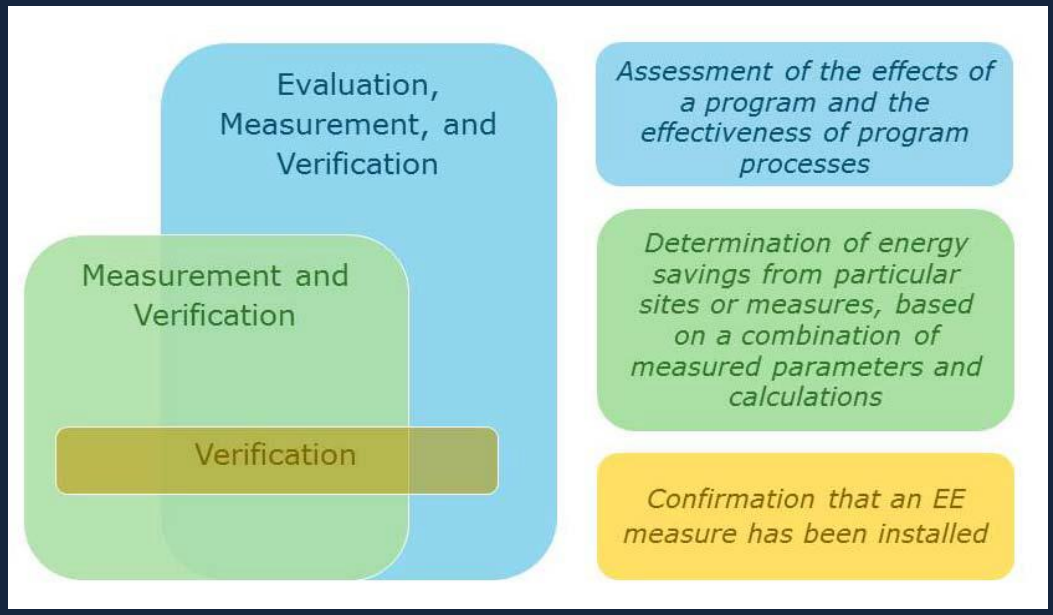
Transforming global energy use to create a clean, prosperous, and secure low-carbon future.

The Promise

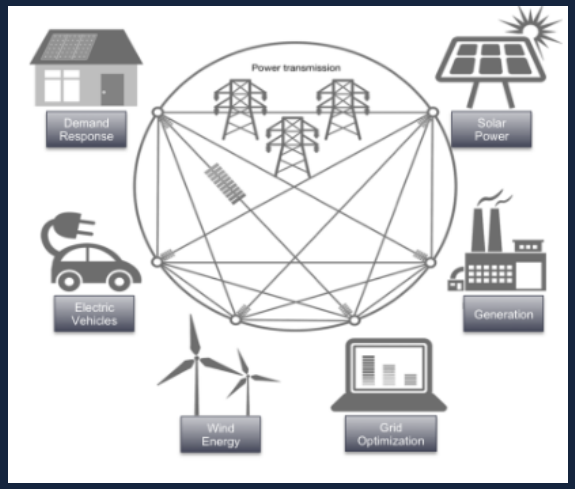
Currently M&V is performed at different times for different reasons

AMI meters lead to larger data volumes that drive interest in automated processes

On-going near-real time M&V can capture load shape impact support valuing EE as a distributed energy resource (DER)



Source: The Changing EM&V Paradigm prepared for the Northeast Energy Efficiency Partnership by DNV GL

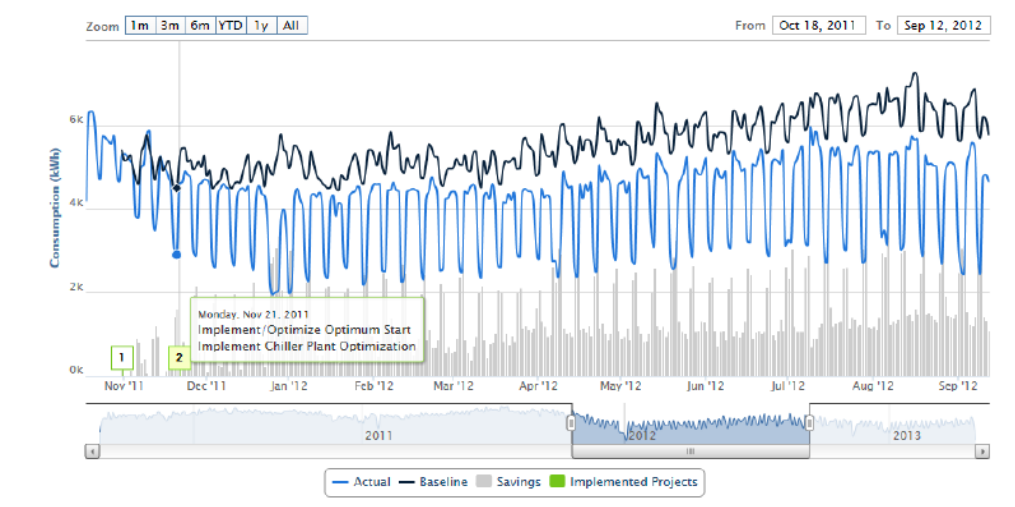


Source: Open Energy Efficiency

The Benefits

- **Owners** will benefit from early warnings of performance issues and enhanced service offerings
- **Service providers** can apply more robust methods to identify and address under performance
- **Program administrators** can adjust program designs more quickly
- **3rd party evaluators** can provide early indicators of savings and potentially hasten the evaluation process
- **Regulators** will appreciate the increased detail and improved claims accuracy
- **Grid Planners** can receive temporal and locational verification of savings

Varied stakeholders will benefit from increased timeliness of savings estimates with improved resolution that provide more actionable insights



Tracking Savings with Automated Software - Source: Retroefficiency

M&V 2.0 Tools

Data rich M&V…
plus so much more

Considerations

- Building type or sector focus
- Tool design intent
- Degree of automation
- M&V method
- Transparency

Realizing the Potential

Key Needs and Opportunities

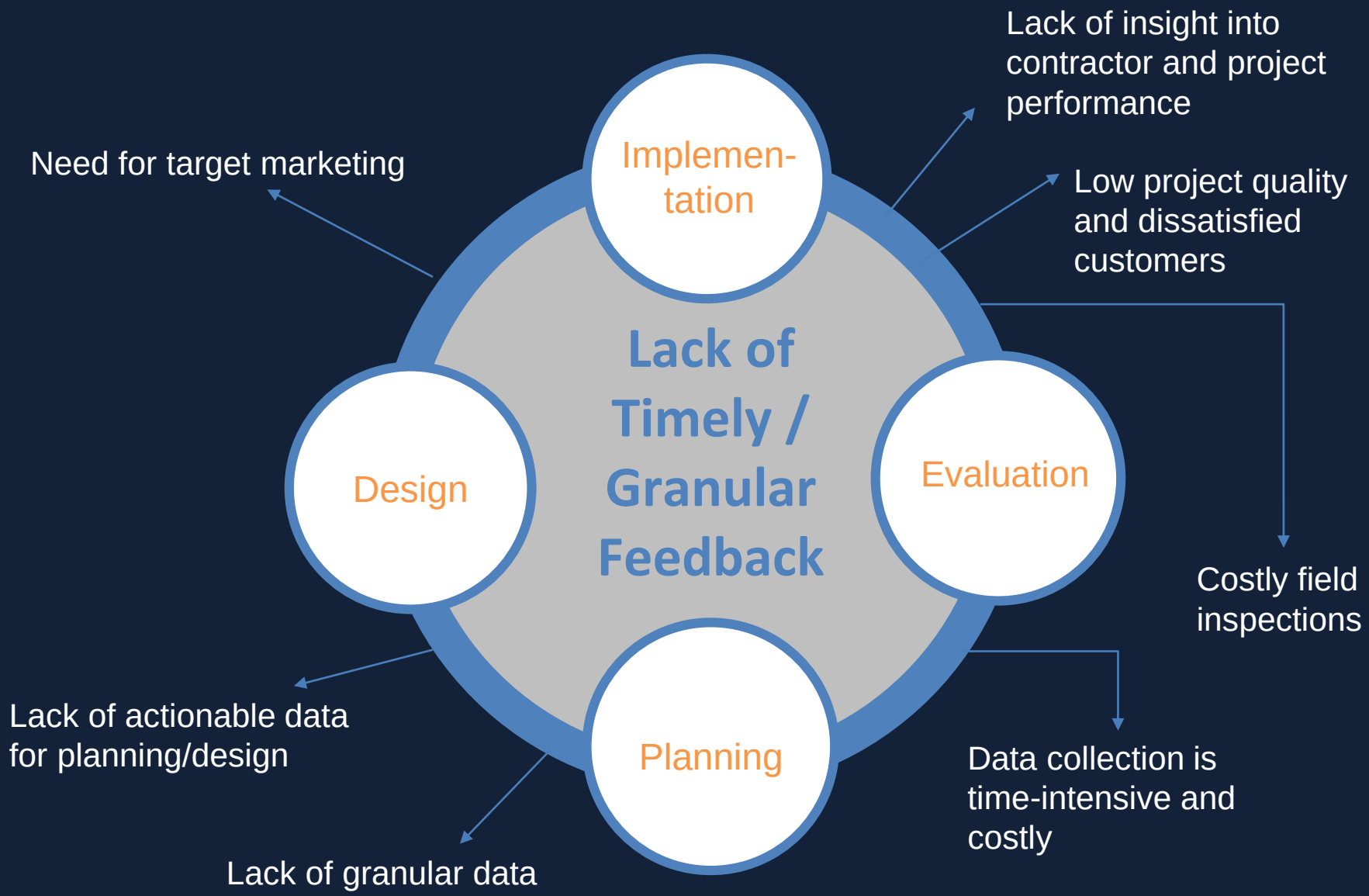
- Data access and quality
- Practitioner workflows
- Model acceptance criteria
- Treatment of baselines
- Cross stakeholder information sharing
- Pilots and case studies

The Status and Promise of Advanced M&V
An Overview of M&V 2.0 Methods, Tools, and Applications

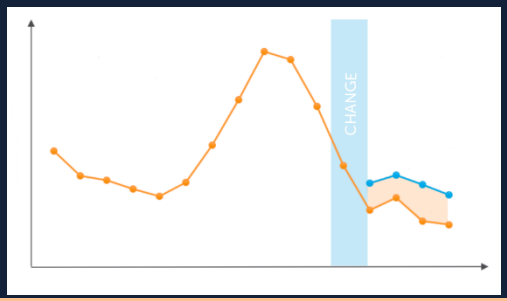
https://rmi.org/news/report-release-status-promise-advanced-mv/
https://eta.lbl.gov/sites/all/files/publications/lbnl-1007125.pdf

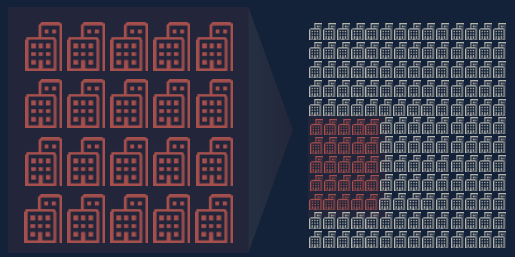
M&V 2.0 AND PROGRAMS

PROGRAM NEEDS AND CHALLENGES



AUTOMATING M&V 2.0 METHODS





Build weather-normalization models for each customer (Res or SMB)

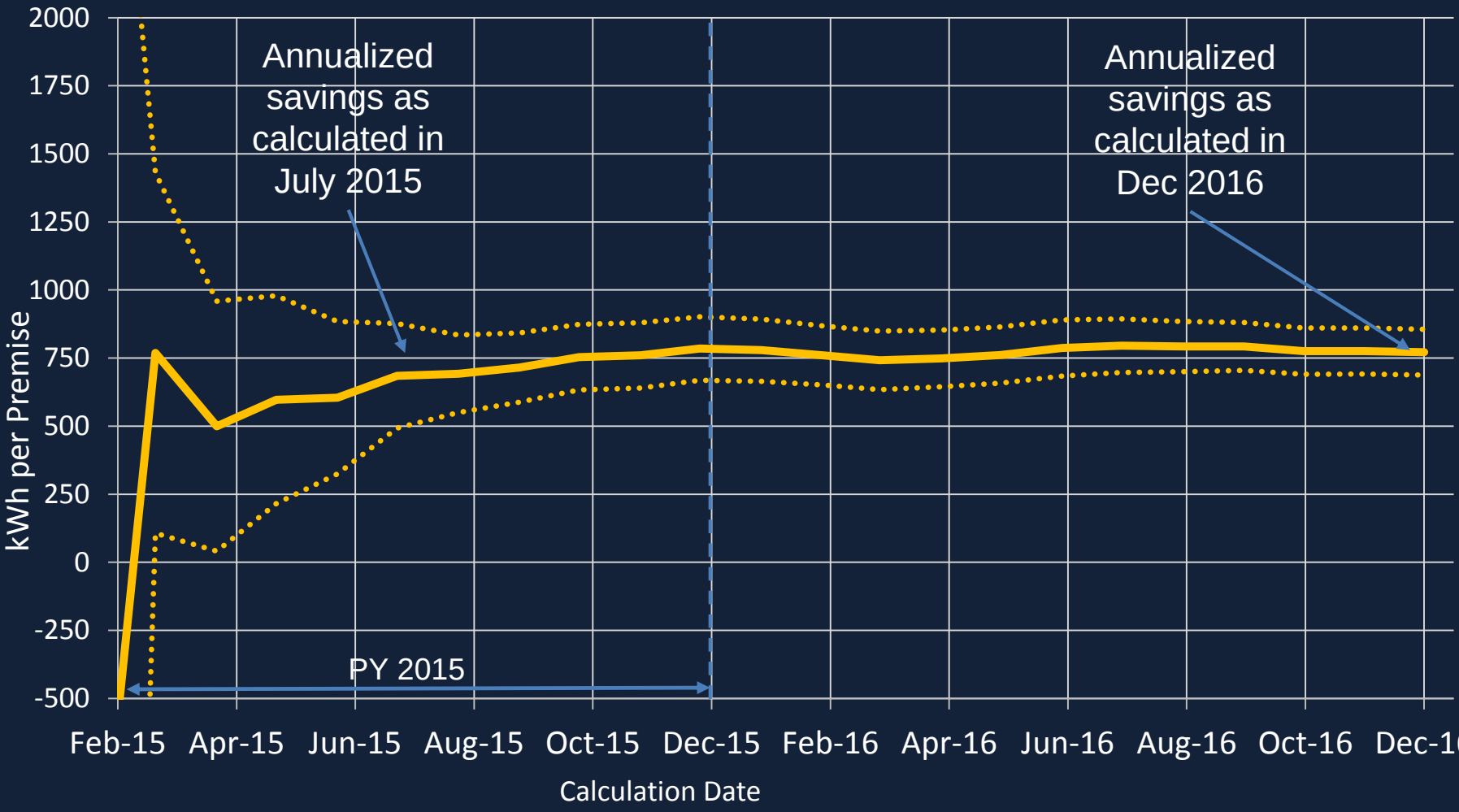
Compare changes in usage for treated customers vs. overall population (comparison groups for bias correction)

Repeat analysis for all customers with each new addition of data

Generate dashboard of findings, analytics and actionable insights

FASTER RESULTS…

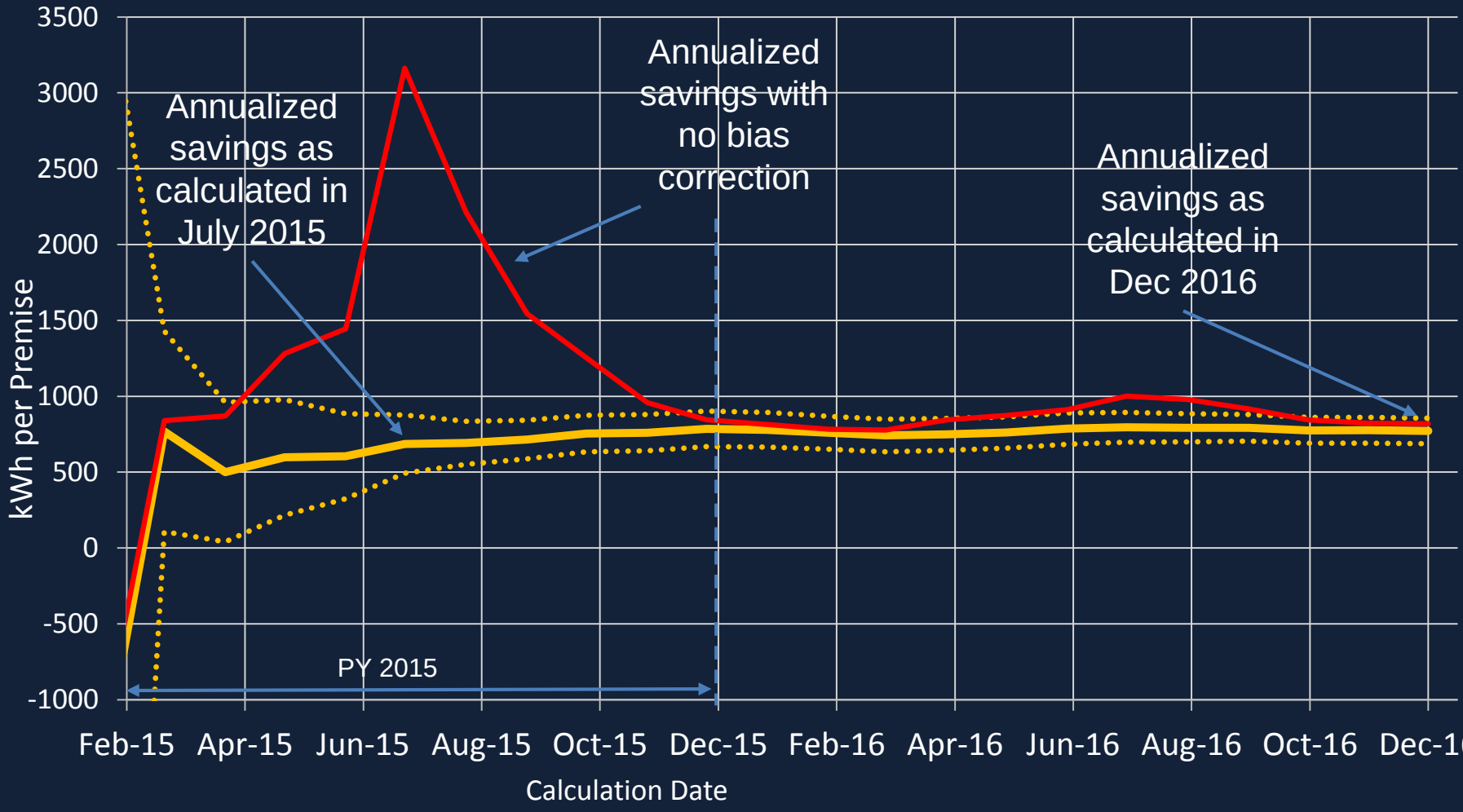
Automation and machine learning for ongoing savings estimates…



**Example is for a cooling measure-dominated program. Programs with heating and cooling measures have shown earlier results*

RELIABLE RESULTS…

- Early estimates are only valuable if they can be trusted. Estimates without a bias correction are unreliable.



EXAMPLES

Program Evaluation

M&V 2.0 IS ACCURATE.

NAVIGANT
DTE Energy
ENERGYSAVVY

VALIDATION PLAN:

Outlined specific criteria by which M&V 2.0 would be judged

GOAL:

Determine if M&V 2.0 produced replicable, accurate results

Residential HVAC Program—energy savings (kWh)	Residential HVAC Program—coincident peak demand (kW)	Insight Behavioral Program
✓ 2015 program-wide realization rate within 10 percentage points?	✓ 2015 program-wide realization rate within 10 percentage points?	✓ 2015 average per-premise kWh savings have overlapping 90% confidence intervals?

Source: DTE & EnergySavvy, Emerging Technology Summit 2017. http://bit.ly/2qUUdS1

Early and Continuous Feedback

M&V 2.0 CAN PRODUCE RELIABLE SAVINGS ESTIMATES MID-WAY THROUGH A PROGRAM YEAR.

One of the promises of M&V 2.0 is that it allows for program impacts to be understood during the program year due to:

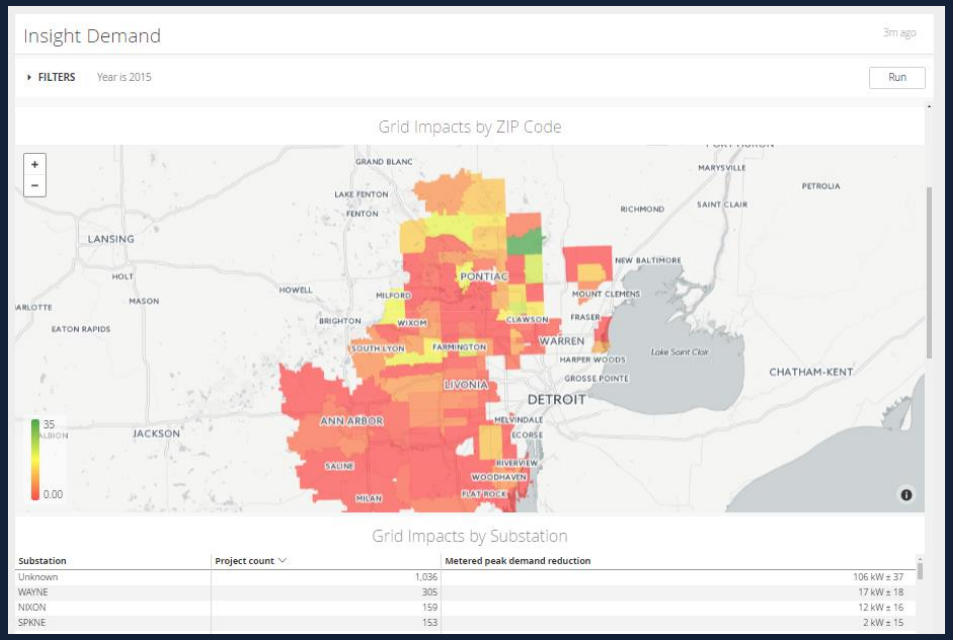
- Measure-as-you-Go nature of the analysis
- High volume of projects that are directly analyzed
- Large one-to-many comparison group methodology

✓ The pilot indicates that this is indeed possible.

Source: DTE & EnergySavvy, Emerging Technology Summit 2017. http://bit.ly/2qUUdS1

Whole Building Energy Savings

M&V 2.0 CAN MEASURE LOW-LEVEL ENERGY SAVINGS (1-2% OF ANNUAL ENERGY USE) & COINCIDENT PEAK DEMAND REDUCTION.



- M&V 2.0 is a good fit for behavioral programs
- Methodology can include a control group
- Tangible EE and PDR difference between lower- and higher-engagement customers

**PDR = Peak Demand Reductions*

Source: DTE & EnergySavvy, Emerging Technology Summit 2017. http://bit.ly/2qUUdS1

STATES TAKING THE LEAD ON M&V 2.0

NY	2016: EM&V Guidance "encourages" use of "Advanced M&V" for data collection and analysis for impact evaluation
CA	2015: Order requires "data collection strategies embedded in the program" and "internal performance analysis during deployment." 2015: law defaults to use of "normalized metered energy consumption" for M&V
CT	2016 State receives DOE SEP grant for EM&V 2.0 pilots
NM	2016 Statewide RFP include optional scope for "M&V 2.0" solutions
MO	In progress: Report on how EM&V 2.0 can support deemed savings updates for statewide TRM
MD	Feb 2017: EmPOWER order calls for use of "tracking actual energy savings…in real time…" for the home performance program
MA	April 2017: Dept of Energy Resources announces market-based residential EE pilot with M&V 2.0 component to measure savings and pay incentives
IL	2016, Future Energy Jobs Act: when practical, shall "incorporate advanced metering infrastructure data into the planning, implementation, and evaluation of energy efficiency…

Discussion/Questions

For more EM&V information see:

- Webinars: https://emp.lbl.gov/emv-webinar-series
- For technical assistance to state regulatory commissions, state energy offices, tribes and regional entities, and other public entities see: https://emp.lbl.gov/projects/technical-assistance-states
- Energy efficiency publications and presentations – financing, performance contracting, documenting performance, etc. see: https://emp.lbl.gov/research-areas/energy-efficiency
- The State and Local Energy Efficiency Action Network (SEE Action) Evaluation, Measurement, and Verification (EM&V) Resource Portal: https://www4.eere.energy.gov/seeaction/evaluation-measurement-and-verification-resource-portal

From Albert Einstein:

"Everything should be as simple as it is, but not simpler"

"Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted"